CIVIL/CONSTRUCTION ENGINEERING TECHNOLOGY TRANSFER ASSURANCE GUIDE (TAG)
November 26, 2019

Ohio Transfer Module:		
Ohio Transfer Module (OTM) Requirements: 36-40 semester hours. Students should select courses within the OTM that complement the selected major and meet any specific general education requirements. Students are encouraged to complete the OTM to ensure maximum transferability and application of credits.		
Required Disciplines	**Minimum Required Hours**	**Recommended Courses**
Area I. English Composition	3 Semester Hours	
Area II. Mathematics	3 Semester Hours	College Algebra (TMM001) and Pre-Calculus (TMM002)
Area III. Arts & Humanities	6 Semester Hours	
Area IV. Social Sciences	6 Semester Hours	General Physics I (Algebra-based) (OSC014). Full sequence may be required by some institutions.
Area V. Natural & Physical Science	6 Semester Hours	
Additional courses beyond the minimum required hours, from any of the disciplines listed above, will count toward the completion of the OTM (36-40 semester hours).		
Advising Note: Students should consult with receiving institution to ensure courses are completed in proper sequence. Students wanting cooperative education programs should consult with target institution as soon as possible.		

Major Courses – Hours/Courses listed below that count toward the major or pre-major requirements	
OET015 – Surveying	Credits: 2-3 Semester Hours
Advising Notes: **Prerequisite -** Placement beyond basic math**.**	
OET016 – Construction Methods and Materials	Credits: 3-4 Semester Hours
Advising Notes:	
OET017 – Soils	Credits: 2-3 Semester Hours
Advising Notes: **Prerequisite -** Statics/Construction Materials Testing	
OET018 – Construction Materials Testing	Credits: 2-3 Semester Hours
Advising Notes: **Prerequisite -** Placement beyond basic math**.**	

Transfer Assurance Guides Total Guaranteed Credits (Range)	
Ohio Transfer Module (OTM)	36 – 40 Semester Hours
Pre-major/Major	0 – 9 to 13 Semester Hours

Institutional Requirements: For entrance and graduation, a transfer student must meet all institutional requirements which would include, but may not be limited to: minimum grade point average, residency requirements, upper division credits attained, minimum grades in specific courses, performance requirements (ex. dance, music) and other requirements of native students from the same institution.

OET015 – Surveying
2-3 Semester Hours
Prerequisite: Placement beyond basic math

Related TAG: Civil/Construction Engineering Technology

Student Learning Outcomes marked with an asterisk (*) are considered essential and must be covered:

1. Demonstrate proper use of modern surveying equipment.*
2. Use accurate measurement techniques to solve construction related problems.*
3. Apply basic mathematical relationships in the surveying process.*

OET016 – Construction Methods and Materials
3-4 Semester Hours

Related TAG: Civil/Construction Engineering Technology

Student Learning Outcomes marked with an asterisk (*) are considered essential and must be covered:

1. Demonstrate a basic understanding of construction drawings.*
2. Understand the terminology related to the building construction.*
3. Identify the people involved in the construction industry.*
4. Know the origin, development and use of common building materials.*
5. Compare methods of construction used in buildings.*

OET017 – Soils
2-3 Semester Hours
Prerequisite: Statics, Construction Materials Testing

Related TAG: Civil/Construction Engineering Technology

Student Learning Outcomes marked with an asterisk (*) are considered essential and must be covered:

1. Compare soil classifications.*
2. Understand the relationship between soil strength characteristics and design of structures.*
3. Demonstrate soil testing procedures.*
4. Identify conventional sub-surface exploration techniques.*
5. Prepare technical reports.*

OET018 – Construction Materials Testing
2-3 Semester Hours
Prerequisite: Placement beyond basic math

Related TAG: Civil/Construction Engineering Technology

Student Learning Outcomes marked with an asterisk (*) are considered essential and must be covered:

1. Employ sound testing procedures on construction materials.*
2. Understand the relevant properties of construction material.*
3. Communicate scientific information in a proper format.*
4. Utilize appropriate standards in the testing of construction materials.*

TMM001 – College Algebra (Revised December 8, 2015; updated samples April 30, 2016)
Typical Range: 3-4 Semester Hours
Recommendation: This course should significantly reflect the Mathematical Association of America's Committee on the Undergraduate Program in Mathematics (CUPM) subcommittee, Curriculum Renewal Across the First Two Years (CRAFTY), College Algebra Guidelines.

College Algebra provides students a college level academic experience that emphasizes the use of algebra and functions in problem solving and modeling, where solutions to problems in real-world situations are formulated, validated, and analyzed using mental, paper-and-pencil, algebraic and technology-based techniques as appropriate using a variety of mathematical notation. Students should develop a framework of problem-solving techniques (e.g., read the problem at least twice; define variables; sketch and label a diagram; list what is given; restate the question asked; identify variables and parameters; use analytical, numerical and graphical solution methods as appropriate; determine the plausibility of and interpret solutions).

– Adapted from the MAA/CUPM CRAFTY 2007 College Algebra Guidelines

To qualify for TMM001 (College Algebra), a course must achieve all of the following essential learning outcomes listed in this document (marked with an asterisk). The Sample Tasks are recommendations for types of activities that could be used in the course.

1. Functions: Successful College Algebra students demonstrate a deep understanding of functions whether they are described verbally, numerically, graphically, or algebraically (both explicitly and implicitly). Students should be proficient working with the following families of functions: linear, quadratic, higher-order polynomial, rational, exponential, logarithmic, radical, and piecewise-defined functions (including absolute value).

The successful College Algebra student can:

1a. Analyze functions. Routine analysis includes discussion of domain, range, zeros, general function behavior (increasing, decreasing, extrema, etc.). In addition to performing rote processes, the student can articulate reasons for choosing a particular process, recognize function families and anticipate behavior, and explain the implementation of a process (e.g., why certain real numbers are excluded from the domain of a given function).*

1b. Convert between different representations of a function.*

1c. Perform operations with functions including addition, subtraction, multiplication, division, composition, and inversion; connect properties of constituent functions to properties of the resultant function; and resolve a function into a sum, difference, product, quotient, and/or composite of functions.*

2. **Equations and Inequalities:** Successful College Algebra students are proficient at solving a wide array of equations and inequalities involving linear, quadratic, higher-order polynomial, rational, exponential, logarithmic, radical, and piecewise-defined functions (including absolute value).

   The successful College Algebra student can:

   2a. Recognize function families as they appear in equations and inequalities and choose an appropriate solution methodology for a particular equation or inequality and can communicate reasons for that choice.*
   2b. Use correct, consistent, and coherent notation throughout the solution process to a given equation or inequality.*
   2c. Distinguish between exact and approximate solutions and which solution methodologies result in which kind of solutions.*
   2d. Demonstrate an understanding of the correspondence between the solution to an equation, the zero of a function, and the point of intersection of two curves.*
   2e. Solve for one variable in terms of another.*
   2f. Solve systems of equations using substitution and/or elimination.*

3. **Equivalencies:** Successful College Algebra students are proficient in creating equivalencies in order to simplify expressions, solve equations and inequalities, or take advantage of a common structure or form.

   The successful College Algebra student can:

   3a. Purposefully create equivalences and indicate where they are valid.
   3b. Recognize opportunities to create equivalencies in order to simplify workflow.*

4. **Modeling with Functions:** Successful College Algebra students should have experience in using and creating mathematics which model a wide range of phenomena.

   The successful College Algebra student can:

   4a. Interpret the function correspondence and behavior of a given model in terms of the context of the model.*
   4b. Create linear models from data and interpret slope as a rate of change.*
   4c. Determine parameters of a model given the form of the model and data.*
   4d. Determine a reasonable applied domain for the model as well as articulate the limitations of the model.*

5. **Appropriate Use of Technology:** Successful College Algebra students are proficient at choosing and applying technology to assist in analyzing functions.

The successful College Algebra student can:

5a. Anticipate the output from a graphing utility and make adjustments, as needed, in order to efficiently use the technology to solve a problem.*
5b. Use technology to verify solutions to equations and inequalities obtained algebraically.*
5c. Use technology to obtain solutions to equations to equations and inequalities which are difficult to obtain algebraically and know the difference between approximate and exact solutions.*
5d. Use technology and algebra in concert to locate and identify exact solutions.*

6. Reasons Mathematically: Successful college algebra students demonstrate a proficiency at reasoning mathematically.

The successful College Algebra student can:
6a. Recognize when a result (theorem) is applicable and use the result to make sound logical conclusions and provide counter-examples to conjectures.*

TMM002 – Pre-Calculus (Revised March 21, 2017)

Typical Range: 5-6 Semester Hours

Recommendation: This course should significantly reflect the spirit of the Mathematical Association of America's Committee on the Undergraduate Program in Mathematics (CUPM), Curriculum Renewal Across the First Two Years (CRAFTY), College Algebra Guidelines.

College Algebra provides students a college-level academic experience that emphasizes the use of algebra and functions in problem solving and modeling, where solutions to problems in realworld situations are formulated, validated, and analyzed using mental, paper-and-pencil, algebraic and technology-based techniques as appropriate using a variety of mathematical notation. Students should develop a framework of problem-solving techniques (e.g., read the problem at least twice; define variables; sketch and label a diagram; list what is given; restate the question asked; identify variables and parameters; use analytical, numerical and graphical solution methods as appropriate; and determine the plausibility of and interpret solutions).

– Adapted from the MAA/CUPM CRAFTY 2007, College Algebra Guidelines

To qualify for TMM002 (Precalculus), a course must achieve all of the following essential learning outcomes listed in this document (marked with an asterisk). These make up the bulk of a Precalculus course. Courses that contain only the essential learning outcomes are acceptable from the TMM002 review and approval standpoint. It is up to individual institutions to determine further adaptation of additional course learning outcomes of their choice to support their students' needs. The Sample Tasks are suggestions/ideas for types of activities that could be used in the course. The Sample Tasks are not requirements. The successful Pre-Calculus student should be able to:

1. **Functions:** Successful Precalculus students demonstrate a deep understanding of functions whether they are described verbally, numerically, graphically, or algebraically (both explicitly and implicitly). Students should be proficient working with the following families of functions: linear, quadratic, higher-order polynomial, rational, exponential, logarithmic, radical, piecewise-defined (including absolute value), and periodic functions.

   The successful Precalculus student can:

   1a. Analyze functions. Routine analysis includes discussion of domain, range, zeros, general function behavior (increasing, decreasing, extrema, etc.), as well as periodic characteristics such as period, frequency, phase shift, and amplitude. In addition to performing rote processes, the student can articulate reasons for choosing a particular process, recognize function families and anticipate behavior, and explain the implementation of a process (e.g., why certain real numbers are excluded from the domain of a given function).*

1b. Convert between different representations of a function.*

1c. Perform operations with functions including addition, subtraction, multiplication, division, composition, and inversion; connect properties of constituent functions to properties of the resultant function; and resolve a function into a sum, difference, product, quotient, and/or composite of functions.*

2. **Geometry:** Successful Precalculus students demonstrate a deep understanding of the measurements of right triangles, right triangles as building blocks of general triangles, and right triangles as a bridge between circular measurements and rectangular measurements.

   The successful Precalculus student can:

   2a. Analyze angles. Routine analysis of angle measurements, units, and arithmetic.*

   2b. Analyze right triangles. Routine analysis of side lengths and angle measurements using trigonometric ratios/functions, as well as the Pythagorean Theorem.*

   2c. Analyze general triangles. Routine analysis of side lengths and angle measurements using trigonometric ratios/functions, as well as other relationships.

3. **Equations and Inequalities:** Successful Precalculus students are proficient at solving a wide array of equations and inequalities involving linear, quadratic, higher-order polynomial, rational, exponential, logarithmic, radical, piecewise-defined (including absolute value), and trigonometric functions.

   The successful Precalculus student can:

   3a. Recognize function families as they appear in equations and inequalities and choose an appropriate solution methodology for a particular equation or inequality, as well as communicate reasons for that choice.*

   3b. Use correct, consistent, and coherent notation throughout the solution process to a given equation or inequality.*

   3c. Distinguish between exact and approximate solutions and which solution methodologies result in which kind of solutions.*

   3d. Demonstrate an understanding of the algebraic, functional, and geometric views of

equation solutions. Solutions to equations can simultaneously serve multiple purposes by representing numbers satisfying an equation, zeros of a function, and intersection points of two curves.*

3e. Solve for one variable in terms of another.*

3f. Solve systems of equations using substitution and/or elimination.*

3g. Cite domain restrictions resulting from solution decisions and situation restrictions and reflect these in solution set descriptions.*

4. **Equivalencies:** Successful Precalculus students are proficient in creating equivalencies in order to simplify expressions, solve equations and inequalities, or take advantage of a common structure or form.

   The successful Precalculus student can:

   4a. Purposefully create equivalences and indicate where they are valid.*

   4b. Recognize opportunities to create equivalencies in order to simplify workflow.*

   4c. Become fluent with conversions using traditional equivalency families.* (e.g., (sin(t)) 2 + (cos(t)) 2 = 1 ; (tan(t)) 2 + 1 = (sec(t)) 2 ; sums/differences; products; double angle; Euler's Formula ($e\ i\theta$ = cos(θ) + i sin(θ)); etc.)

5. **Modeling with Functions:** Successful Precalculus students should have experience in using and creating mathematics which models a wide range of phenomena.

   The successful Precalculus student can:

   5a. Interpret the function correspondence and behavior of a given model in terms of the context of the model.*

   5b. Create linear and periodic models from data and interpret slope as a rate of change.*

   5c. Determine parameters of a model given the form of the model and data.*

   5d. Determine a reasonable applied domain for the model, as well as articulate the

limitations of the model.*

6. **Appropriate Use of Technology:** Successful Precalculus students are proficient at choosing and applying technology to assist in analyzing functions.

   The successful Precalculus student can:

   6a. Anticipate the output from a graphing utility and make adjustments, as needed, in order to efficiently use the technology to solve a problem.*

   6b. Use technology to verify solutions to equations and inequalities obtained algebraically.*

   6c. Use technology to obtain solutions to equations and inequalities which are difficult to obtain algebraically and know the difference between approximate and exact solutions.*

   6d. Use technology and algebra in concert to locate and identify exact solutions.*

7. **Reasons Mathematically:** Successful Precalculus students demonstrate a proficiency at reasoning mathematically.

   The successful Precalculus student can:

   7a. Recognize when a result (theorem) is applicable and use the result to make sound logical conclusions and to provide counter-examples to conjectures.*

Additional Optional Learning Outcomes

The OTM Mathematics, Statistics, and Logic Statewide Faculty Review Panel stresses that the essential learning outcomes marked with an asterisk make up the bulk of a Precalculus course and needs to continue as the focus of this course. Courses that contain only the essential learning outcomes are acceptable from the TMM002 review and approval standpoint. It is up to individual institutions to determine further adaptation of additional course learning outcomes of their choice to support their students' needs. The Statewide Review Panel will not use the additional optional learning outcomes for evaluative purposes and emphasizes that institutions must consider them as optional.

Some institutions expressed an interest in including additional optional learning outcomes to gain such guidance as possibilities to support students' needs. The OTM Mathematics, Statistics, and Logic Statewide Faculty Review Panel developed a few examples in this section, but please know that the additional learning outcomes are absolutely optional and not required. If your institution chooses to explore additional learning outcome(s), the examples below are simply suggestions and not restricted or exhaustive of possibilities. Please note that the samples provided here were crafted as a way to show how to purposefully tie back to the associated required items and to deem as extensions of the essential learning outcomes.

2. **Geometry:** Successful Precalculus students demonstrate a deep understanding of the measurements of right triangles, right triangles as building blocks of general triangles, and right triangles as a bridge between circular measurements and rectangular measurements.

   The successful Precalculus student can:

   2d. Describe two-dimensional position using rectangular and polar coordinates, vectors, and parametric equations; demonstrate fluency between any two of these systems; and recognize when one representation would be useful over another in simplifying workflow.

   2e. Interpret the result of vector computations geometrically and within the confines of a particular applied context (e.g., forces).

   2f. Represent conic sections algebraically via equations of two variables and graphically by drawing curves.

8. **Sequences and Series:** Successful Precalculus students are proficient in manipulating sequences and series, as well as approximating functions with series.

   The successful Precalculus student can:

8a. Represent sequences verbally, graphically, and algebraically, including both the general term and recursively.

8b. Write series in summation notation and represent as sequences of partial sums verbally, numerically, and graphically.

8c. Identify and express the general term of arithmetic and geometric sequences and write the sum of arithmetic and geometric series.

8d. Use “limits” of geometric series as functions by converting between series representation and closed forms, as well as using this bridge for composition and re-centering.

OSC021 – General Physics Sequence (Algebra-based)

This is a combination of OSC014 Algebra based Physics I and OSC015 Algebra based Physics II.

OSC014 – Algebra-based Physics I (w/ labs)
4-5 Semester Hours
Co-requisites: College Algebra and Pre-calculus

Related TAGs: Biology, Chemistry, Civil/Construction Engineering Technology, Electrical Engineering Technology, Mechanical Engineering Technology

Understanding and/application of the following topics using calculus concepts and methods where appropriate:

1. Kinematics – one and two dimensional
2. Vectors – vector Arithmetic
3. Force and Newton's Laws of Motion
4. Work, Energy, Conservation of Energy
5. Linear momentum
6. Collisions
7. Rotational kinematics and dynamics
8. Angular momentum and rotational energy
9. Simple harmonic motion
10. Waves and sound
11. Solid and fluid properties
12. Heat and thermodynamics
13. Kinetic theory of gases

OSC015 – Algebra-based Physics II (w/labs)
4-5 Semester Hours
Co-requisites: College Algebra and Pre-calculus

Related TAGs: Chemistry, Civil/Construction Engineering Technology, Electrical Engineering Technology, Mechanical Engineering Technology

Understanding and/application of the following topics using algebra concepts and methods where appropriate:

1. Electric field, potential, forces
2. Current, magnetic field integration over continuous charge/current distribution
3. Quantum physics
4. Atomic physics
5. Nuclear physics
6. Induction and Inductance
7. Resistance
8. Capacitance
9. Basic circuit analysis
10. Electric power
11. EMF
12. Electromagnetic waves
13. Kirchhoff's Law
14. R-L-C circuits
15. Faraday's Law
16. Conductivity
17. Geometric optics
18. Diffraction
19. Interference
20. Polarization

CIVIL/CONSTRUCTION ENGINEERING TECHNOLOGY TAG

FACULTY PARTICIPANTS – NOVEMBER 2019

Name	Institution
Marcia Belcher (Panel Lead)	University of Akron
Tom Comisford	Central Ohio Technical College
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Eric Dunn	Sinclair College
Geoffrey Wopershall	Stark State College
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Joe Sanson	Youngstown State University

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Name	Institution
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Bob Mergel	Columbus State Community College
Robert Stroup	Southern State Community College
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Al Wahle	Sinclair Community College
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